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ACCELERATED PORK PROCESSING. Fresh-Frozen Pork Chops

INTRODUCTION

PACKERS converting pork carcasses into wholesale cuts would profit by eliminating large holding coolers or using holding coolers more efficiently. Accelerated pork processing as described by Mandigo (1967, 1968) and Henrickson (1968) could result in a significant reduction in processing time while eliminating unnecessary processing steps.

Several laboratory studies demonstrated the feasibility of producing acceptable wholesale cuts of pork using the accelerated processing techniques (Moore et al., 1966; Weiner et al., 1966; Davidson et al., 1968; and Henrickson, 1968). However, Marsh and Legt (1966) and Weiner et al. (1966) noted that pork frozen within 35 min to 1 hr postmortem resulted in tough loins due to thaw rigor and cold shortening. Davidson et al. (1968) and Mandigo and Henrickson (1966) found no significant differences in percentage moisture and Warner-Bratzler shear values of hams due to accelerated vs. conventional processing methods. Weiner et al. (1966) and Moore et al. (1966) found fresh loins produced by the accelerated technique to be as acceptable as loins produced by conventional processing.

Mandigo (1968) indicated that accelerated processing of pork carcasses needed to be evaluated under commercial packing house conditions. Consequently, a study was implemented to determine the effect of accelerated and conventional processing of pork loins at the commercial packing house level on fresh-frozen pork chops.

MATERIALS & METHODS

THE LOINS from 60 pork carcasses used in this study were processed as wholesale fresh pork loins in the George A. Hormel and Company packing plant at Fremont, Nebr. Removal of the pork loin (NAMP No. 410, NAMP, 1970) from the carcass was done according to the standard methods of the packing plant.

Left and right sides were alternately assigned to the treatments of accelerated or conventional processing of pork loins. Accelerated processing is defined as the removal of the loin from the carcass within 1 hr postmortem, with fabrication to a finished wholesale cut prior to initial chilling of the cut. Conventional processing is a control, fabricated in the same manner, except fabricated after 24 hr of carcass chilling at 1.7°C.

The accelerated processed pork loins were divided into three groups according to the chill temperature used to chill the loins to an average temperature of 4.4°C after fabrication. Each group represented a differenct experiment. 20 loins were chilled at −45.5°C, −28.9°C and −17.8°C with an air flow velocity of 1.5m/sec. Paired loins from the same carcasses were conventionally processed and required 24 hr to reach a mass average temperature of 4.4°C at the thickest part. Accelerated processed pork loins required approximately 2 hr to reach a mass average temperature of 4.4°C.

The chilled loins were shipped to the University of Nebraska-Lincoln, and were frozen at −23.3°C. Five chops (1.27-mm thick) were removed anteriorly from the separation of the tenth and eleventh ribs while 15 chops were removed posteriorly, from the tenth and eleventh rib cut of the frozen loins. As soon as the pork chops were identified and trimmed of fat and bone, the boneless chops were placed in individual plastic bags and frozen. After all loin samples were processed, the bags were packed in dry ice and air-shipped to the U.S. Army Natick Laboratories, Natick, Mass.

The chops were stored at −28.9°C until they could be analyzed for tenderness. The frozen chops were weighed and a 5-g sample was removed from each chop to make a composite loin sample for proximate analysis, pH and water-holding capacity determination for each loin. The chops were reweighed and wrapped in aluminum foil to prevent moisture loss and facilitate identification. Each chop was identified as to loin number, processing method and chop location within the loin. The odd numbered chops from each loin were treated as fresh-frozen pork chops while the even number chops were freeze dried. This report will be concerned only with the fresh-frozen pork chops.

The proximate analysis (fat, protein, moisture and ash) was according to the procedures by AOAC (1965). The water-holding capacity test procedure was that of Wierbicki et al. (1957). The process was modified to use 10g of sample per centrifuge tube.

The fresh-frozen pork chops were equilibrated to 4.4°C and were penetrated with a Meat Penetrometer (Hinnergardt and Tuomy, 1970). The peak of the force curve was used in analyzing the data.

The penetrated raw pork chops were cooked to an internal temperature of 76.7°C using 6 psi steam pressure in a three compartment Steam Chef oven. The cooked chops were cooled for 2 hr at 4.4°C and then penetrated again. Following penetration, pork chops numbered seven and nine were paired and 17 and 19 were paired from each loin for evaluation by a 10-member taste panel.

Two samples were served at each taste panel session and evaluated for color, aroma, flavor, appearance and tenderness. The two samples represented a comparison of fresh-frozen pork chops from pork loins which were convention and accelerated processed.

The rating scales used by the taste panel for evaluation of color, aroma, flavor and appearance were based on a one to nine scale. A rating

Table 1—Tenderness of fresh-frozen pork chops equilibrated to 4.4°C before cooking as determined by the meat penetrometer[a]

Chill temp for accelerated processed loins[b]	Processing method for loins: Accelerated	Conventional	$S\bar{x}$
−45.5°C	3.31	3.03	0.06
−28.9°C	3.25	3.22	0.08
−17.8°C	4.30	4.42	0.10

[a] Shear force values reported as pounds force required to penetrate a 1.27-cm thick pork chop.
[b] Each chill temperature represents a separate experiment.

Table 2—Tenderness of fresh-frozen pork chops cooked to an internal temperature of 76.7°C at 6 psi steam pressure

Chill temp for accelerated processed loins	Processing method for loins: Accelerated	Conventional	$S\bar{x}$
	Meat penetrometer[c]		
−45.5°C	8.76[a]	8.67[a]	0.13
−28.9°C	8.27[a]	8.49[a]	0.14
−17.8°C	8.85[a]	9.06[a]	0.28
	10-member taste panel rating[d]		
−45.5°C	4.61[a]	4.83[b]	0.07
−28.9°C	3.81[a]	3.89[b]	0.04
−17.8°C	3.54[a]	3.45[a]	0.04

[a,b] Means with unlike superscripts are different ($P < 0.01$).
[c] Shear force values reported as pounds force required to penetrate a 1.27-cm thick pork chop.
[d] The acceptable tenderness range was from 3–7 using a rating scale of 1 = tough and 9 = tender.

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Table 3–Flavor, odor, color and acceptance of cooked pork chops evaluated by a 10 member taste panel[e]

Chill temp for accelerated processed loins	Processing method for loins Accel-erated	Conven-tional	$S\bar{x}$
	Flavor		
–45.5°C	5.55[a]	5.62[b]	0.04
–28.9°C	5.58[a]	5.53[a]	0.03
–17.8°C	4.96[a]	5.12[a]	0.04
	Odor		
–45.5°C	5.80	5.75	0.01
–28.9°C	5.97	5.96	0.01
–17.8°C	5.53	5.53	0.03
	Color		
–45.5°C	5.91	5.86	0.01
–28.9°C	6.05	6.10	0.01
–17.8°C	5.72	5.69	0.01
	Acceptance		
–45.5°C	5.71[c]	5.71[c]	0.03
–28.9°C	5.91[c]	5.95[c]	0.01
–17.8°C	5.56[c]	5.64[d]	0.03

a,b Means with unlike superscripts are different ($P < 0.05$).
c,d Means with unlike superscripts are different ($P < 0.01$).
e Rated on a 1–9 scale (1 = extremely poor; 9 = excellent)

of one was extremely poor while a rating of nine was excellent. The tenderness rating scale was also based on a one to nine rating. It differed from the hedonic scale used for color, aroma, flavor and appearance as only three of the nine points were given a word description relating to tenderness. The number one position was labeled tough, the number five position was designated as ideal tenderness, and the number nine position was labeled tender. Tough was defined as resembling leather and tender as offering no resistance to chewing, thus being mushy or lacking texture. Ideal tenderness was defined as being slightly chewy, firm and juicy. A pretest session was held to familiarize panel members in the use of the rating scales.

Data were analyzed using analysis of variance methods described by Bennett and Franklin (1954), Snedecor (1956) and Ralston and Wilf (1960) for differences due to processing methods, loins and chops.

Table 4–Percent cooking loss of pork chops from accelerated and conventionally processed pork loins

Chill temp for accelerated processed loins	Processing method for loins Accel-erated	Conven-tional	$S\bar{x}$
–45.5°C	34.42	35.05	0.54
–28.9°C	31.96	32.54	0.37
–17.8°C	38.95	36.90	0.82

Table 5–Proximate analysis of accelerated and conventional processed pork loins

Chill temp for accelerated processed loins	Processing method for loins Accel-erated	Conven-tional	$S\bar{x}$
	Moisture, %		
–45.5°C	70.38	70.49	.20
–28.9°C	69.93	70.07	.20
–17.8°C	70.31	70.67	.17
	Protein, %		
–45.5°C	22.55	22.46	.12
–28.9°C	22.48	22.32	.16
–17.8°C	22.06	22.23	.19
	Fat, %		
–45.5°C	6.52	6.11	.22
–28.9°C	6.26	6.22	.16
–17.8°C	5.75	5.65	.20
	Ash, %		
–45.5°C	1.11	1.13	.01
–28.9°C	1.13	1.13	.01
–17.8°C	1.13	1.13	.01

RESULTS & DISCUSSION

THE UNIFORM REMOVAL of pork chops from loins of accelerated and conventionally processed pork loins did not result in any differences between chop weights for the two processing methods. Chop size varied with the size of loins used. Since loins from the same carcass were used to compare processing methods for loins, the comparison was made using matched left and right loin pork chops of approximately the same size.

Objective measurement for tenderness, both prior to cooking and following cooking to an internal temperature of 76.7°C did not indicate a difference in tenderness of pork chops due to the processing method of pork loins within each experiment (Tables 1 and 2). In two of three experiments, the taste panels found significant ($P < 0.01$) differences between processing methods.

The meat penetrometer was used to objectively measure tenderness of 10 pork chops from each loin while the taste panel was allowed to test only two samples from each loin for each treatment. The fact that the penetrometer had a larger sampling of the chop population than did the taste panel may account for some of the variations in the taste panel findings. Within each experiment and tenderness evaluation technique, the actual difference in tenderness was very small. While the taste panel found only small tenderness differences in pork chops due to loin processing, the differences in tenderness were consistent. However, all of the taste panel tenderness values fell within an acceptable range.

Table 6–pH and water-holding capacity of accelerated and conventional processed pork loins

Chill temp for accelerated processed loins	Processing method for loins Accel-erated	Conven-tional	$S\bar{x}$
	pH		
–45.5°C	5.68[a]	5.75[b]	0.02
–28.9°C	5.63[a]	5.67[c]	0.01
–17.8°C	5.56[a]	5.59[a]	0.01
	Water-holding capacity[d]		
–45.5°C	22.88	22.38	0.83
–28.9°C	22.67	23.00	0.63
–17.8°C	24.87	24.77	0.74

a,b Means with unlike superscripts are different ($P < 0.01$).
a,c Means with unlike superscripts are different ($P < 0.05$).
d Water-holding capacity = percent juice lost.

The results of the taste panel for flavor, color, aroma and appearance are summarized in Table 3. The taste panel found no differences in the flavor, color, aroma or appearance of fresh-frozen pork chops from loins processed either by the accelerated or conventional method.

The percent cooking loss of pork chops (Table 4) from accelerated and conventionally processed pork loins was approximately the same within experiments. These results tend to confirm the work of Moore et al. (1966) who found no significant difference in cooking loss attributable to the hot (accelerated) or cold (conventional) cutting methods for loin samples.

No significant differences were found within experiments for moisture, protein, fat, water-holding capacity and ash due to loin processing method (Table 5 and 6). Moore et al. (1966) also found no significant differences in moisture loss of pork loin roasts because of the cutting method. However, differences in moisture, protein, fat and ash were found among loins ($P < 0.01$) due to animal variation.

The accelerated processed pork loins demonstrated a consistently lower final pH value than the conventionally processed pork loins even though this difference was not significant in experiment three (Table 6).

The data presented in Tables 1 through 6 tend to confirm the laboratory findings of Davidson et al. (1968), Mandigo and Henrickson (1966), Moore et al. (1966) and Weiner et al. (1966) which demonstrated the laboratory feasibility of producing acceptable wholesale cuts of pork using the accelerated pork processing method. From this study, one could conclude that acceptable fresh-frozen pork chops can be made using the accelerated processing technique for pork carcasses under commercial processing conditions.

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